



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Contents lists available at ScienceDirect

Journal of Cardiology Cases

journal homepage: www.elsevier.com/locate/jccase

Case Report

A 17-year-old male with acute myocarditis following mRNA-1273 vaccination in Japan

Ayumi Iwamuro (MD) *, Tomoki Sasa (MD), Takafumi Kawai (MD), Mamoru Taguchi (MD), Masayasu Izuhara (MD, PhD), Takashi Uegaito (MD, PhD), Keisuke Shioji (MD, PhD)

Department of Cardiology, Kishiwada City Hospital, Osaka, Japan

ARTICLE INFO

Article history:

Received 27 December 2021
 Received in revised form 10 March 2022
 Accepted 16 March 2022
 Available online xxxx

Keywords:

mRNA-1273
 Vaccine
 Myocarditis
 Young male
 CMR
 Case report

ABSTRACT

Vaccinations are the main tool being used to control the COVID-19 pandemic. When the Japanese Ministry of Health approved the Moderna mRNA-1273 vaccination in May 2021, it was limited to patients over 18 years old; however, using the additional data of efficacy and safety from clinical trials, vaccination was approved for 12- to 17-year-olds in Japan in July 2021. A previous study reported that myocarditis after the mRNA-1273 vaccination was more prevalent in young men; however, no patients under 18 years old with myocarditis diagnosed by cardiovascular magnetic resonance (CMR) findings after mRNA-1273 vaccination have been reported in Japan. In the present case, a 17-year-old healthy male developed arthralgia and had fever on the day of the second mRNA-1273 vaccination for severe acute respiratory syndrome coronavirus 2. Three days after the vaccination, the patient felt severe chest pain with broad ST elevations on electrocardiography and troponin T elevations. Symptoms and findings rapidly improved; however, on CMR, myocarditis remained. Thus, it is necessary to be vigilant of potential acute myocarditis in young men following mRNA-1273 vaccination.

Learning objective: Although it is very rare, acute myocarditis after mRNA-1273 (Moderna) vaccination developed within 3–5 days following the second dose of the vaccine.

Most reported cases were mild or moderate in severity, but there were cases of cardiogenic shock. We need to be vigilant of acute myocarditis in young men following mRNA-1273 vaccination.

© 2022 Japanese College of Cardiology. Published by Elsevier Ltd. All rights reserved. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Vaccinations are the main tool being used to control the COVID-19 pandemic. When the Japanese Ministry of Health approved the Moderna mRNA-1273 vaccination in May 2021, it was limited to patients over 18 years old; however, using the additional data of efficacy and safety from clinical trials, vaccination was approved for 12- to 17-year-olds in Japan in July 2021. Myocarditis after mRNA-1273 vaccination has been reported [1]. Furthermore, a study reported that post-vaccine myocarditis was more prevalent in young men [2]. Acute myocarditis after mRNA-1273 vaccination in children under 18 years old is rare (28.8 per million people as previously reported by the Japanese Ministry of Health [www.mhlw.go.jp, p. 49]).

We present a case of acute myocarditis after mRNA-1273 vaccination in a 17-year-old patient, including cardiovascular magnetic resonance (CMR) imaging findings.

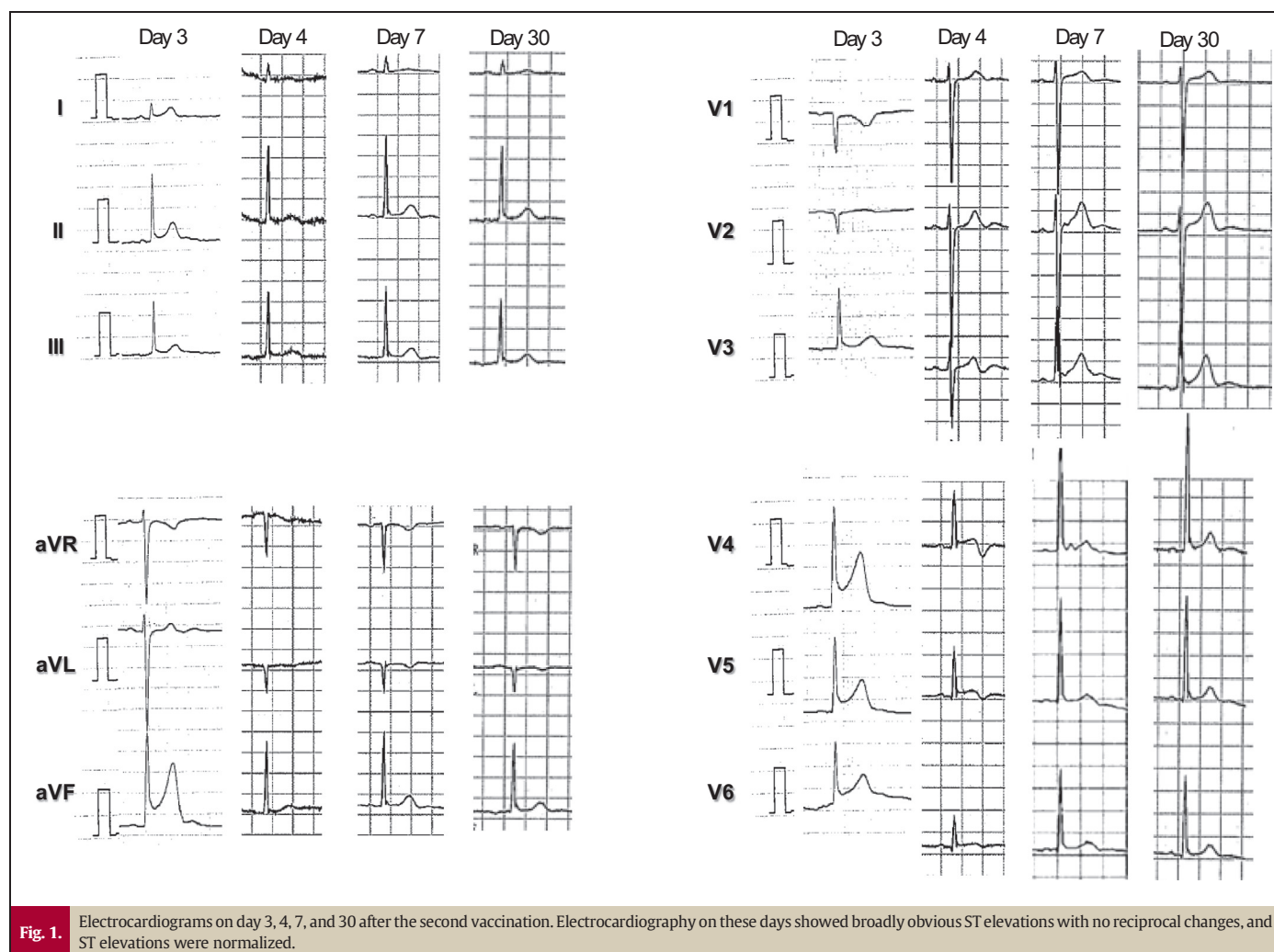
Case report

A 17-year-old healthy male developed arthralgia and a fever of 38 °C on the day of the second dose of the mRNA-1273 severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2) vaccine (Moderna). He presented to a clinic 3 days after vaccination with sharp substernal severe chest pain. Physical examination revealed a fever of 37.7 °C, blood pressure of 121/64 mmHg, pulse of 71/min, and oxygen saturation of 98% on room air. As electrocardiography (ECG) revealed sinus rhythm and broadly obvious ST elevations with no reciprocal changes (Fig. 1), he was transferred to our hospital. Initial laboratory results showed an elevated troponin T (TnT) of 0.327 ng/m (normal range: <0.014 ng/ml), creatine kinase of 337 U/L (normal range: 59–248 U/L), and high c-reactive protein (CRP) of 1.87 mg/ml (normal range: <0.14 mg/ml) with normal NTproBNP of 99.4 pg/ml (normal range: 0–125 pg/ml). His liver and renal functions were normal. A nasopharyngeal SARS-

* Corresponding author at: Department of Cardiology, Kishiwada City Hospital, 1001 Gakuhara-cho, Kishiwada City 596-8501, Japan.
 E-mail address: aiwamuro@me.com (A. Iwamuro).

<https://doi.org/10.1016/j.jccase.2022.03.012>

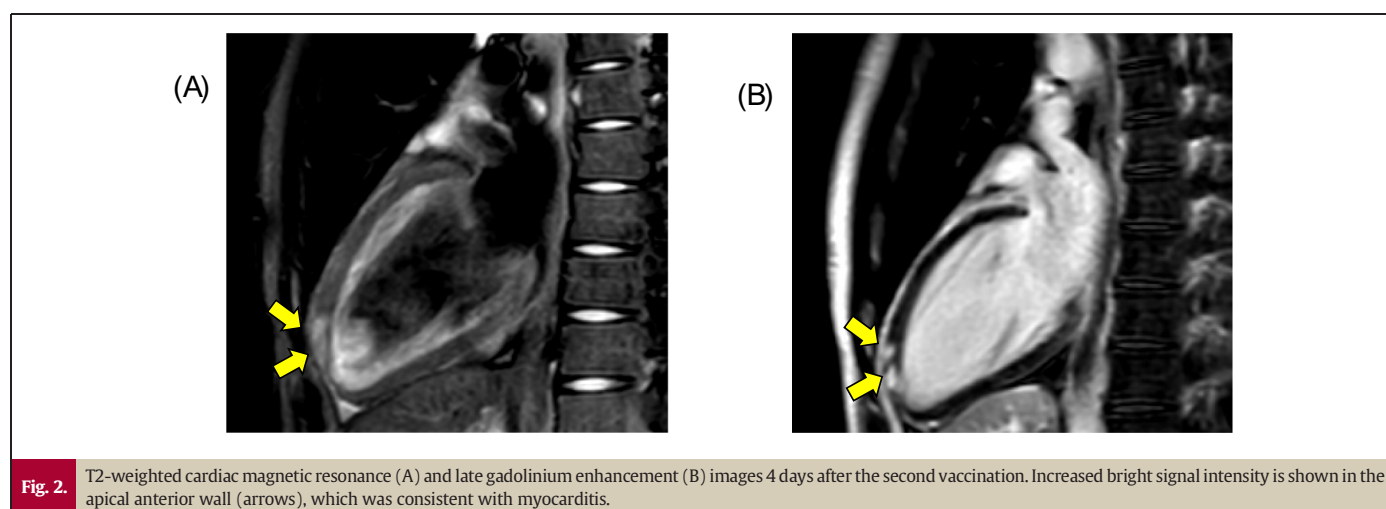
1878-5409/© 2022 Japanese College of Cardiology. Published by Elsevier Ltd. All rights reserved. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



Cov-2 antigen test was negative. Transthoracic echocardiography demonstrated normal ventricle wall thickness, normal chamber size, normal systolic function, and normal volume of pericardial effusion. We did not test for viruses that cause myocarditis. We diagnosed acute myocarditis due to mRNA-1273 vaccination based on his background, clinical course, ECG, and echocardiography. The patient was admitted to our

hospital for observation and was treated with acetaminophen for 3 days until the fever subsided.

CMR was performed 4 days after vaccination to clarify the myocardial damage (Fig. 2). Cine imaging showed normal left ventricular size, wall thickness, and contraction without pericardial effusion. T2-weighted imaging revealed increased bright signal intensity in the



apical anterior wall, which indicated myocardial edema (Fig. 2A). Late gadolinium enhancement CMR imaging showed focal late enhancement in the same lesion with non-ischemic regional distribution, which indicated myocarditis (Fig. 2B). Using the 2018 Lake Louise criteria [3], these findings were consistent with a diagnosis of acute myocarditis.

After 2 days in hospital, his fever had subsided and his TnT and CRP had normalized. He was discharged without complications.

At the outpatient checkup one month later, his ECG findings, TnT, CRP, and NTproBNP were normalized, and exercise tolerance was maintained with AT-VO₂ of 113% in the cardiopulmonary exercise stress test.

Discussion

We present a 17-year-old male with acute myocarditis after mRNA-1273 vaccination, including CMR imaging findings. The patient had typical symptoms with ECG changes on the third day after the vaccination. Thus, we diagnosed the patient as having developed myocarditis three days after the second vaccination. His symptoms rapidly improved. A previous study reported that most cases of myocarditis developed within a few days after the second dose of vaccine [4].

In a previous study of patients (n = 136) with definite or probable myocarditis in Israel, 19 patients presented after the first dose of vaccine and 117 patients after the second dose [4]. A previous study reported that most cases of myocarditis were mild or moderate in severity; however, there were cases of cardiogenic shock [2]. Multisystem inflammatory syndrome in children (MISC) has been reported, which is a serious condition that appears to be linked to COVID-19 vaccination [5]. This patient had fever for 3 days and developed myocarditis, but did not have any other organ abnormalities and did not go into shock; thus, he did not meet the diagnostic criteria for MISC. Most cases of MISC develop

within 2–6 weeks; thus, patients with post-vaccine myocarditis should be monitored for several months after the onset of the disease.

Young patients with mild or moderate chest pain may not seek medical attention. Thus, subclinical myocarditis may occur and be detectable by active surveillance. The primary concern of clinicians is not the incidence of serious side effects of vaccines, but the likelihood of outcomes, such as myocardial damage, in the patients that they treat.

Although the benefits of vaccines outweigh the risks, our findings suggest that myocarditis may occur after mRNA-1273 vaccination in young men.

Declaration of competing interest

The authors declare that there is no conflict of interest.

References

- [1] Kim Han W, Jenista Elizabeth R, Wendell David C, Azevedo Clerio F, Campbell Michael J, Darty Stephen N, et al. Patients with acute myocarditis following mRNA COVID-19 vaccination. *JAMA Cardiol* 2021;6:1196–201.
- [2] Witberg Guy, Barda Noam, Hoss Sara, Richter Ilan, Wiessman Maya, Aviv Yaron, et al. Myocarditis after Covid-19 vaccination in a large health care organization. *N Engl J Med* 2021;385(23):2132–9.
- [3] Luetkens Julian A, Faron Anton, Isaak Alexander, Dabir Darius, Kuetting Daniel, Feisst Andreas, et al. Comparison of original and 2018 Lake Louise criteria for diagnosis of acute myocarditis: results of a validation cohort. *Radiol Cardiothorac Imaging* 2019; 1(3):e190010.
- [4] Mevorach D, Anis E, Cedar N, Bromberg M, Haas EJ, Nadir E, et al. Myocarditis after BNT162b2 mRNA vaccine against Covid-19 in Israel. *N Engl J Med* 2021;385:2140–9.
- [5] Salzman Mark B, Huang Cheng-Wei, O'Brien Christopher M, Castillo Rhina D. Multisystem inflammatory syndrome after SARS-CoV-2 infection and COVID-19 vaccination. *Emerg Infect Dis* 2021;27(7):1944–8.